Algae Biofuel Performance Assessment

PATAR Assignment
Andrea Drzewianowski
EDC 371
October 22, 2012

Option 2:
I, Andrea Drzewianowski, did not work with another colleague. I had not outside help.

Signature: 

Audience: High School Biology II Class Grade 11 or 12

Title: Algae Biofuel Performance Assessment

Briefs synopsis:
1. Interpret data in graphs and tables to make a decision in a real-life science application
2. Write a short <1 page paper making a scientific claim and backing it up with evidence from data.
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Specific Standards:

Standards from Massachusetts Science and Technology/Engineering Curriculum Framework, October 2006 http://www.doe.mass.edu/frameworks/current.html

Scientific Inquiry Skills Standards:
SIS3. Analyze and interpret results of scientific investigations: Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the hypothesis

SIS4. Communicate and apply the results of scientific investigations: Explain diagrams and charts that represent relationships of variables and construct a reasoned argument.

Rhode Island Common Core Standards for English language Arts Literacy in science
1. Write arguments focused on discipline-specific content
1a. Introduce precise claim(s), distinguishing the claim(s) from alternate or opposing claims and create an organization that establishes clear relationships among the claim(s), counter claims reasons and evidence.

Algae-Biofuel Performance Assessment

Task Objectives:

1. Interpret data in graphs and tables to make a decision in a real-life science application
2. Write a short 1-page e-mail making a scientific claim and backing it up with evidence from data.

Background information: Algae based biofuel is a hot research topic in the alternative energy field. The oil we are using today came from deposits of phytoplankton (microscopic water plants) that were exposed to heat and pressure thousands of years ago. The idea behind algae based bio-fuel is to grow phytoplankton/micro-algae and extract the oils now, without waiting for thousands of years. Once the oil is extracted the rest of the biomass can still be utilized and be fed to livestock or be fermented to produce ethanol, another alternative fuel. **Advantages**: Algae harnesses solar energy through photosynthesis and in the process it consumes CO_2. This means we are not releasing any new CO_2 to the atmosphere. Algae can be grown in areas not suitable for growing food crops and can use plentiful sources of water such as seawater or algae can even be grown in waste water and help strip the waste water of extra nutrients making it cleaner for the environment. **Disadvantages:** The cost to grow and process the algae biomass into oil is high. Current research is looking into new technology that makes it cheaper to grow the algae and then extract the oil. Discovery of strains that grow better under specific conditions and produce large amounts of oils is also needed.

Assignment Detailed Description:

You are a lab technician working for PhytoFuel, a biotech startup company, trying to develop a new algae based fuel for cars. Your job is to run experiments on different strains of algae and to determine the best strain to pass on to the development group for further testing. Your boss, Mr. Alga, has asked you to analyze your latest results and to send him an email explaining what strain to pass on to the development group and why. You have the following data to analyze:

- Growth curve of the 5 strains showing cells/mL over time for high temp. Be sure to look at the growth rate (slope) as well as the final yield of cells (biomass).
- Oil Yield Table- Lists % oil content for each strain

The ideal strain would grow at a fast rate to a large biomass yield and have a high oil content per cell. PhytoFuel is growing the algae in shallow ponds in New Mexico where the average temperature ranges from 7-27°C over the course of a year so the strain must grow over a range of temperatures.

In your email be sure to specify which strain looks the most promising and why. Reference specific figures and tables as you provide evidence to support your claim. You are writing to your boss so be sure to have your response well organized and use correct spelling, grammar, and punctuation. Note: results from real experiments are not always clear which means that there may not be one strain that is perfect. The explanation of why you selected the strain and the evidence you provide is more important than the strain you select.

See the attached rubric for specific grading requirements.

You have 20-30 minutes for this task.

Experimental Data

Figure 1: The log growth of strains A-E at 20°C.

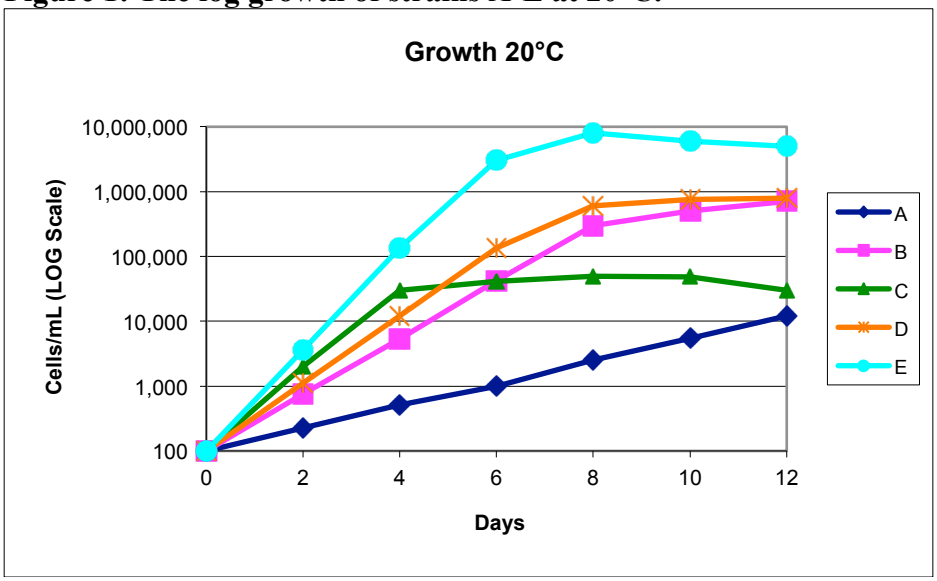

Figure 2: The Log growth of strains A-E at 10°C.

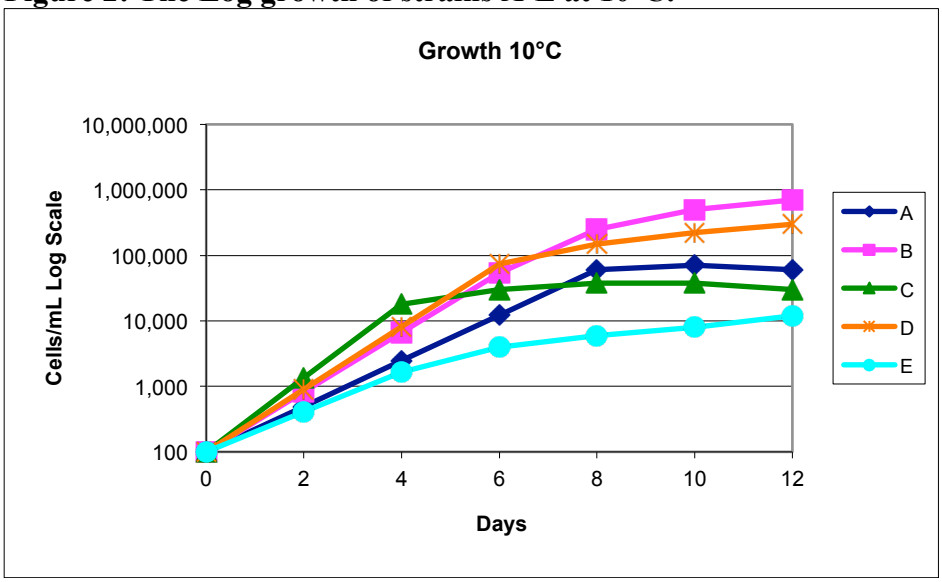

Table 1: The Percent oil per weight of dry biomass	
Strain	**% Oil**
A	**48%**
B	**57%**
C	**63%**
D	**50%**
E	**42%**

Grading Rubric

Criterion	Not Acceptable	Acceptable	Target
Strain Selection (5)	The strain selected meets few to none of PhytoFuel's requirements: growth rate, oil content, biomass, and temperature. (0-1)	The strain selected meets several of the PhytoFuel's requirements: growth rate, oil content, biomass, and temperature (2-3)	The strain selected meet most of PhytoFuel's requirements: growth rate, oil content, biomass, and temperature. (4-5)
Evidence and Support (10)	Provides little or no evidence for supporting claims. The evidence provided does not indicates correct analysis of the figures and tables. Does not use specific references to graphs and tables. (0-3)	Provides some evidence for three to four of their supporting claims. The evidence provided indicates mostly correct analysis of the figures and tables. Does not always use specific references to graphs and tables (4-7)	Provides evidence for each supporting claim. The evidence provided indicates correct analysis of the figures and tables. Uses specific reference to graphs and tables. (8-10)
Organization and Mechanics (2)	Writing is un-organized such that the reader is unable to understand the rational for selecting the strain. There are more than 6 spelling, punctuation, and grammar mistakes (0)	Organization does not always make clear relationships between claims and evidence. There are 3-6 spelling, punctuation, and grammar mistakes (1)	Writing is concise, following organization that makes clear relationships between claims and evidence. Less than 2 spelling, punctuation, and grammar mistakes. (2)

Student # 1
Mr. Alga
Objective:
Analyze Five separate strains of algae to determine which is has a superior combination of the following traits:
High growth rate at 7-72 F. and high oil yield.

Five separate strains (A, B, C, D, E) were tested for the following:
Growth at High Temperatures (20C)
Growth at Low Temperatures (10C)
Oil Yield

Based On the analysis of strains tested. (Refer to graphs below) it is recommended that strain B be further developed.

Strain B performs well in all categories.
In high temp growth, it grows on a steady pace to produce a healthy 500,000 cells/ml by day 8 and an impressive 1,000,000 cells/ml by day 12. Only strain E out performed this growth, with strain D begins about the same growth rate as B.

In Low Temp Growth B is clearly the superior strain. It grows at nearly the same rate as at high temps, implying it has strong stable growth at a wide range of temperatures. While strain E performed well at high temperatures, it was the worst performer at low temperature, yielding a mere 10,000 cells/ml by day 12.

Finally Strain B yields the second most oil at 57%. While strain A yielded more at 63%, it was below average in growth at both high and low temperatures.

Based on this analysis, strain B is recommended for further development.

Strain 5/5 You took into consideration growth rate, biomass, temperature, and oil content. You were looking for a strain with strong, stable growth and wisely chose strain B.
Support & Evidence 8/10- You need to reference both figures and tables in the text for each fact mentioned. For example "In low temp growth B is clearly the superior strain (Figure 2)."
Organization 1/2- Pay attention to your grammar and spelling as you had several mistakes.

Total 14/17

Student # 2

Mr. Alga,

Currently, the lab is examining 5 strains of algae: A, B, C, D, and E. All 5 strains have been tested at a low water temperature of 10 degrees C. and at a high water temperature of 20 degrees C. These two temperatures are representative of the high and low water temperature ranges expected in the target area in New Mexico.

- Strain C provides the highest yield of oil – 63%. However, at both the upper and lower temperature ranges, its growth rate performed at second from the bottom.
- Strain B provides the second highest yield of oil – 57%. It had the fastest growth in the low temperature range and tied with strain D in having the second fastest growth rate in the high temperature range. Strain D's growth rate ramped up faster than strain B, but by day 12 strain B had caught up
- Strain D provides the third highest yield of oil – 50%. It had the second fastest growth rate in the low temperature range and tied with strain B in the high temperature range.
- Strain A provides the second poorest yield of oil – 48%. It had the poorest overall performance. Not only does it provide a poor oil yield, but it was in the middle of the pack for growth in the low temperature range, and the poorest growth performance in the high temperature range.
- Strain E provides the poorest yield of oil – 42%. Although it has the fastest growth rate at the higher temperature range, it had the slowest in the lower temperature range.

Based on this preliminary analysis, the current recommendation is strain B. It has the second highest oil yield; at the lower temperature range, it had the fastest growth; at the higher temperature range it tied with the strain D having the second fastest growth rate.

This decision should be reworked once the distribution of pond temperature across a full year have been mapped. It is known that the temperature range for the ponds is 7 degree C. to 27 degrees C. But if it is found that there are significantly more days in the high range, than strain E's very fast grown rate may compensate for its lower oil yield. If on the other hand, it is found that there are more low temperature days, than strain B, again, seems the most advantageous as it provided both a high oil yield and the fastest growth rate in the lower temperature range.

Regards,

Student # 2

PhytoFuel

Strain: 5/5- You selected a strain that meets most of Phytofuels requirements

Evidence & Support: 5/10- In your analysis of the graphs you do not differentiate between growth rate and biomass yield. These are different. The growth rate is the slope of the beginning of the graph and the biomass yield is the maximum cell concentration at the end of the growth curve. You also did not reference specific figures. For example “Strain E provides the poorest yield of oil - 42%, (Table 1).”

Organization 2/2- Your e-mail was easy to understand and had good punctuation, grammar and spelling.

Total 12/17

Student # 3

Dear Mr. Alga,
Here is my analysis of the latest experimental data gathered from the last round of experiments. After looking the data, strain E at 20 degrees Celsius had the highest growth rate reaching 10,000,000 cells/mL at day 8 before dying back slightly on day 12(figure 1). However, strain E has the lowest percentage of oil at only 42% which despite its high numbers makes it less practical (figure 3). Also when the temperature decreases to 10 degrees Celsius the growth rate drops tremendously to only 10,000 cells/mL(figure 2). The best strain to choose despite not reaching the 10,000,000 cells/mL, is strain B. Stain B has consistent growth of close to 1,000,000 cells/mL at both 10 and 20 degrees Celsius (figure 1 and figure 2). Plus it has the second highest oil amount at 57 % (figure 3). It is second only to strain C which is 63% (figure 3) but does not have near the growth potential as strain B (figure 1 and figure 2). So my overall conclusion is that strain B is the algae that we should pursue in our future research.

Sincerely,
Student # 3
PhytoFuel
Research Development Team

Strain 5/5- You selected a strain based that mees PhytoFuel's Requirements.
Evidence & Support 7/10- In your analysis of the graphs you do not differentiate between growth rate and biomass yield. These are different. The growth rate is the slope of the beginning of the graph and the biomass yield is the maximum cell concentration at the end of the growth curve. You did reference the specific figures.
Organization 1/2- The organization of your email was difficult to follow at times.

Total 13/17

Student # 4

10/18/12

To: Dr. Alga

From: Student # 4

RE: Algae Strain Recommendation

After analyzing the latest Growth Logs and percentage of biomass production, I feel that Strains B and C are our top two picks. Besides having the higher percentage of oil content over Strains A, D, & E, Strains B and C have a more consistent biomass rate of gain over a wider temperature range during the 12 day test period.

Comparing Strain B in Figures 1 and 2, you can see that the increase in biomass is basically the same between 10 and 20 degrees Celsius. This rate of gain would result in an over all higher and consistent yield during the course of the year providing stability in production and keeping up with demand from our buyers. Again comparing Figures 1 and 2, the biomass of Strains B and C grow basically at the same rate through day four but Strain B continues to increase its biomass as Strain C plateaus.

Now Strain C does have a 6% higher oil content than Strain B but it does not produce as much biomass. I feel that the amount of additional biomass production of Strain B would more that compensate for the higher oil content in Strain C giving the company the best opportunity for consistent high oil production over the course of the year.

My final decision is to use Strain B.

Strain 5/5- You selected a strain that meets PhytoFuels requirements.
Evidence & Support 9/10- Overall your evidence backed up your claim, your analysis examined growth rate, biomass yield, temperature, and oil content. You first paragraph needed specific references of figures.
Organization 2/2- Well done. Your e-mail was easy to follow and contained no grammar, spelling or punctuation mistakes

Reflection

I think that this assessment is fair to all types of learners as well as to students of different cultural backgrounds. I selected this assignment because the fuel crisis is universal. Everyone is experiencing the pinch of rising fuel costs and the environmental impact of using fossil fuels. I chose biofuels because this is current research being done in both the private sector and at universities. I was hoping that involving a current topic would interest more students. I also asked them to make a decision that would need to be made in real lab. This assessment will help students get a better idea of what working in a laboratory may entail. I chose a Biology II class because Bio II students should be able to handle the analysis of 4 different factors simultaneously and weigh different strains. I would not expect that of an introductory biology course.

I tried to design the data so that at least two strains would be good picks but the four students all selected the same strain. I was torn between making it realistic where you might get two strains that are very good in different areas but are overall the same and making it too difficult to select a strain at all. Two of the students did suggest that two strains are good and one student mentioned that more temperature analysis was needed because one strain performed really well at high temperatures but not at low and if there were more hot days than cold it may be worth testing that strain more. These were the types of critical thinking I was looking for but I did not specifically ask for that kind of thinking. I think if I did this again I could give a list of leading questions for the students to think about before responding. Those questions could include.

1. Would you select another strain if one of the requirements was different or removed?
2. What strain characteristic do you think is the most important?